# COL341 - Assignment 2

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## 1 Implementation of kernels

Following are the formulas that have been used for the implemention of each kernel.

### 1.1 Linear

$$\mathrm{k}(\mathbf{x}, \mathbf{z}) = \mathbf{x}^\top \mathbf{z}$$

### 1.2 Polynomial

$$\mathbf{k}(\mathbf{x}, \mathbf{z}) = \left(c + \gamma(\mathbf{x}^\top \mathbf{z})\right)^d$$

### 1.3 RBF

$$\mathbf{k}\left(\mathbf{x}, \mathbf{z}\right) = \exp\left(-\gamma \left\|\mathbf{x} - \mathbf{z}\right\|^2\right)$$

### 1.4 Sigmoid

$$\mathbf{k}\left(\mathbf{x}, \mathbf{z}\right) = \tanh\left(\gamma x^T z + r\right)$$

### 1.5 Laplacian

$$\mathbf{k}\left(\mathbf{x}, \mathbf{z}\right) = e^{-\gamma \|x - z\|}$$

## 2 Binary SVM

### 2.1 Linear

The following is the confusion matrix obtained for c=0.01,0.1,1.0, and 10.0

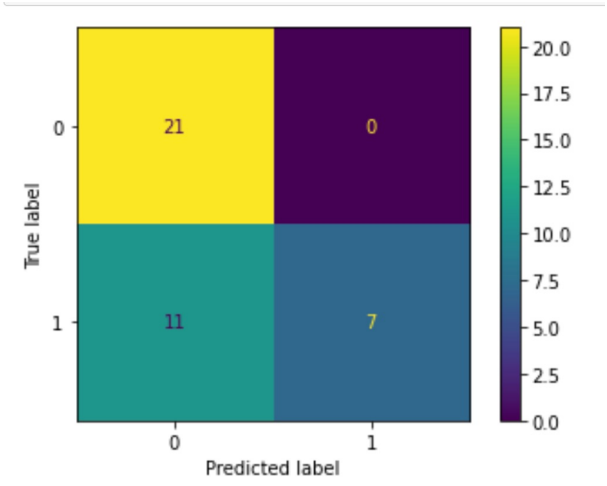


**Figure 1: accuracy = 71.7%**

## 2.2 RBF

The best result is obtained when c=0.1, and gamma is 0.001 with an accuracy of 92.3

### 2.2.1 C = 0.01, $\gamma = 0.001$

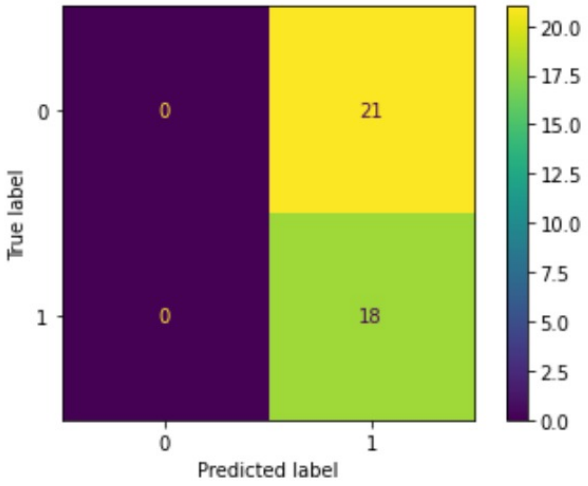


**Figure 2: Accuracy = 46%**

### 2.2.2 C = 0.1, $\gamma = 0.001$

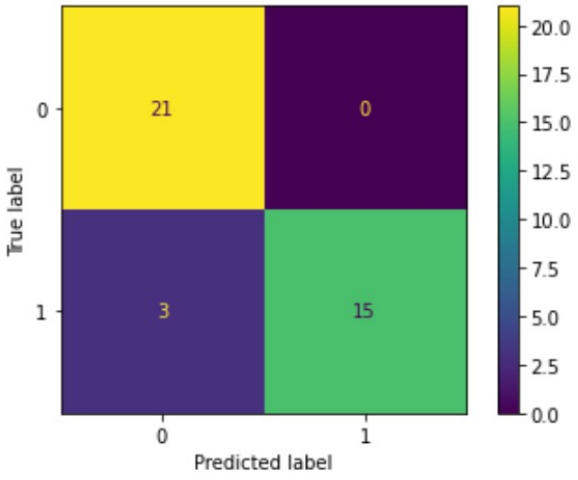


**Figure 3: accuracy = 92.3%**

### 2.2.3 C = 1.0, $\gamma = 0.001$

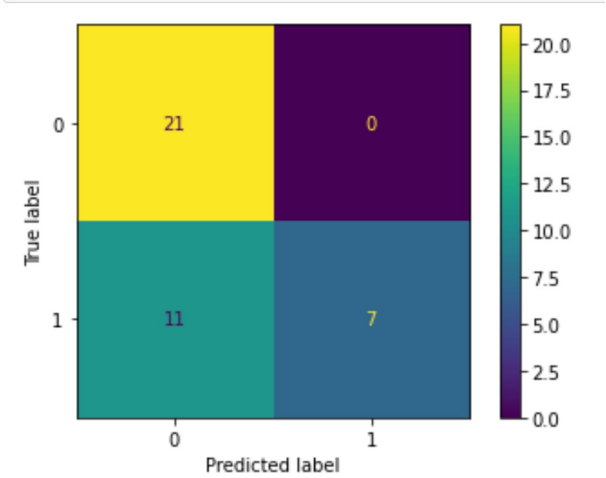


**Figure 4: accuracy = 71.7%**

### 2.2.4 C = 10.0, $\gamma = 0.001$

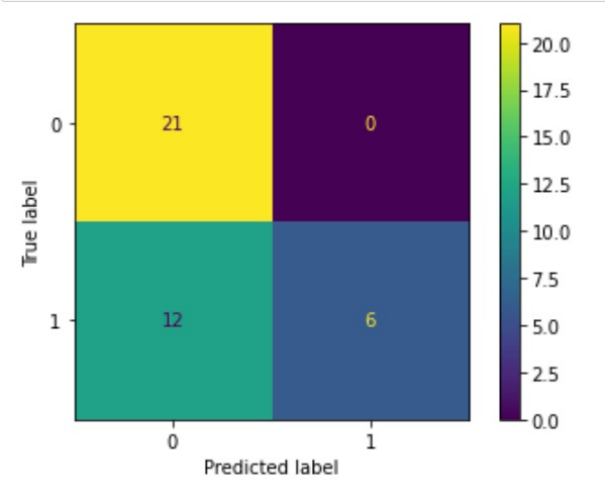


**Figure 5: accuracy = 69.23%**

### 2.2.5 C = 0.01, $\gamma = 0.01$

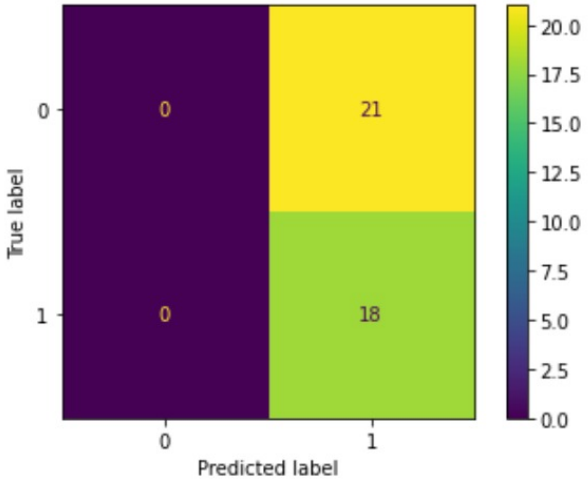


**Figure 6: Accuracy = 46.15%**

### 2.2.6 C = 0.1, $\gamma = 0.01$

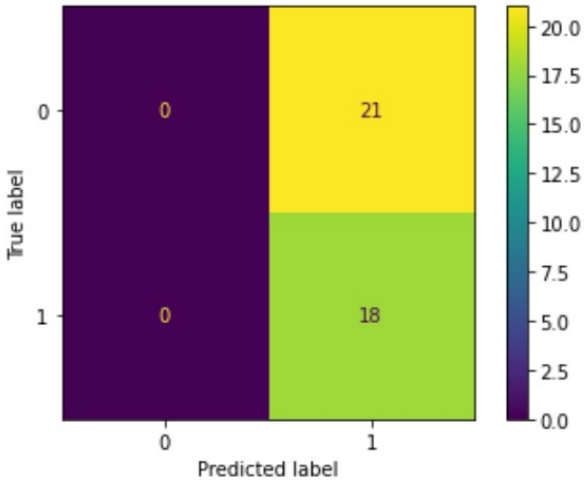


**Figure 7: Accuracy = 46.15%**

### 2.2.7 C = 1.0, $\gamma = 0.01$

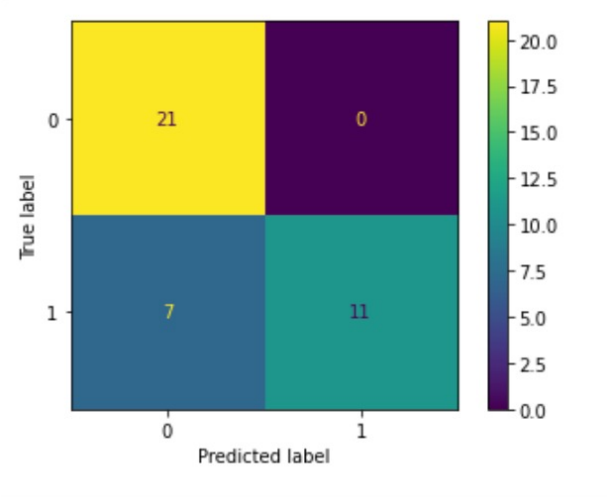


**Figure 8: Accuracy = 82.05%**

### 2.2.8 C = 10.0, $\gamma = 0.01$

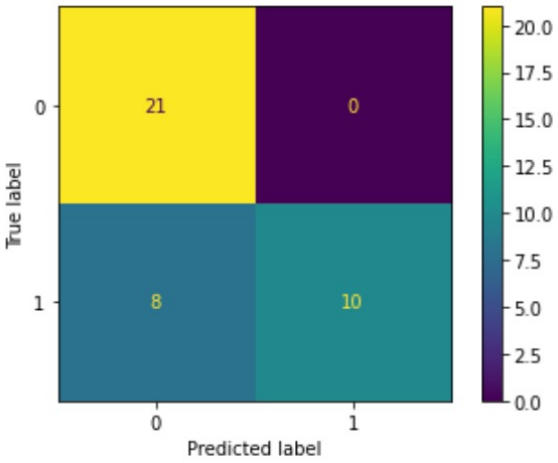


**Figure 9: Accuracy = 79.48%**

#### 2.2.9 C = 0.01, $\gamma = 0.1$

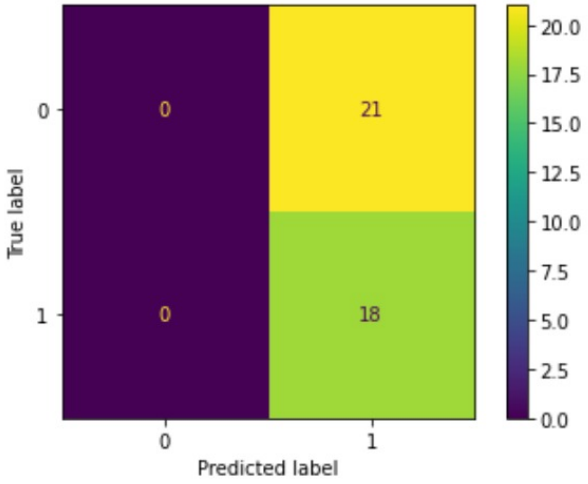


**Figure 10: Accuracy = 46.15%**

#### 2.2.10 C = 0.1, $\gamma = 0.1$

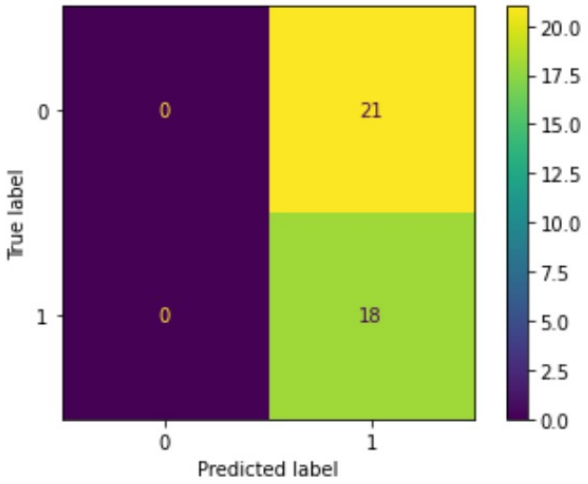


**Figure 11: Accuracy = 46.15%**

#### 2.2.11 C = 1.0, $\gamma = 0.1$

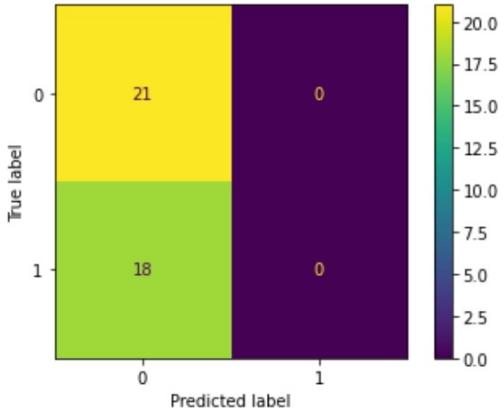


**Figure 12: Accuracy = 53.84%**

#### 2.2.12 C = 10.0, $\gamma = 0.1$

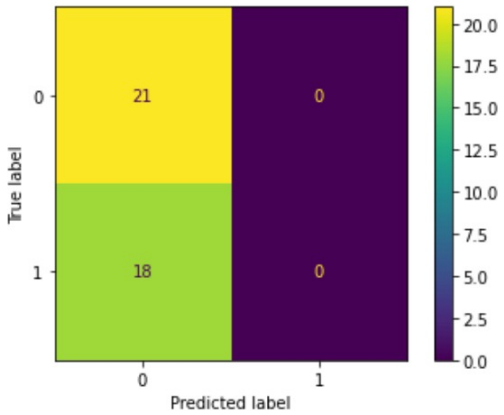


**Figure 13: Accuracy = 53.84%**

# 3 Multi-class Classification

## 3.1 One-vs-One

### 3.1.1 C = 0.1, $\gamma = 0.1$

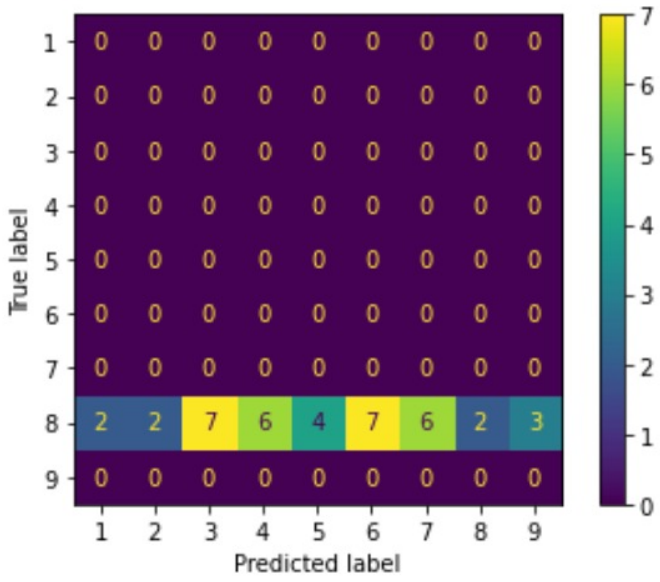


**Figure 14: Accuracy = 5.12%**

### 3.1.2 C = 1.0, $\gamma = 0.1$

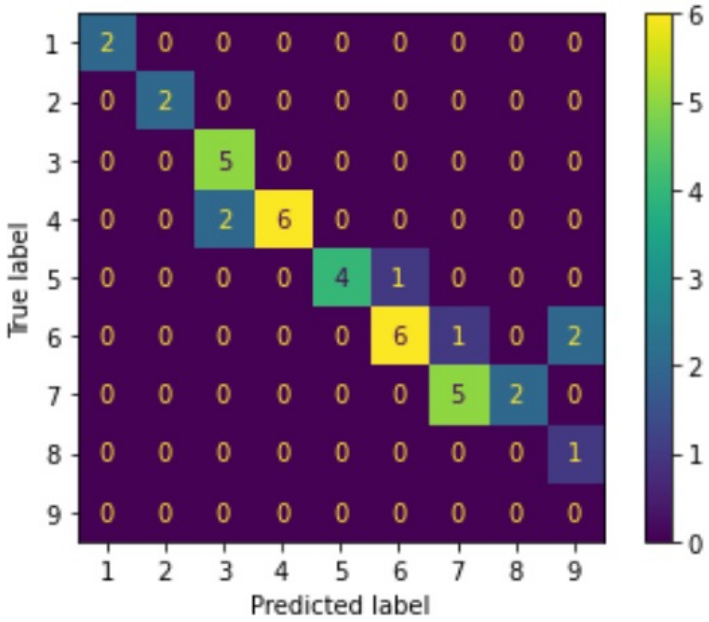


**Figure 15: Accuracy = 76.92%**

## 3.2 One-vs-All

### 3.2.1 C = 0.1, $\gamma = 0.1$

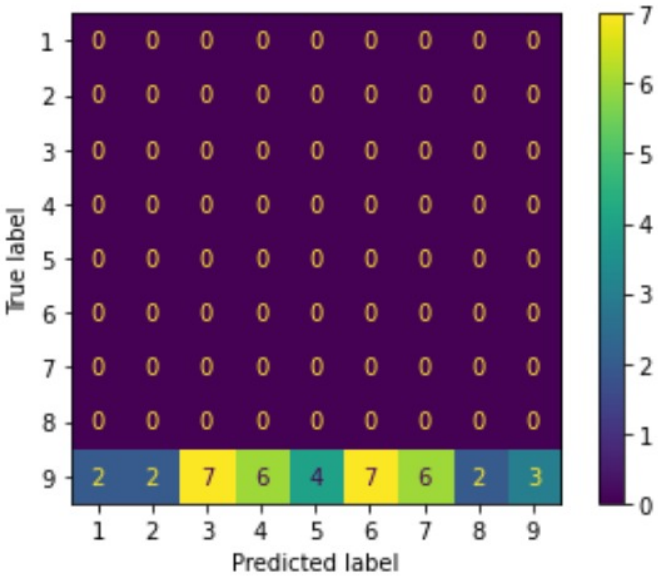


**Figure 16: Accuracy = 7.7%**

### 3.2.2 C = 1.0, $\gamma = 0.1$

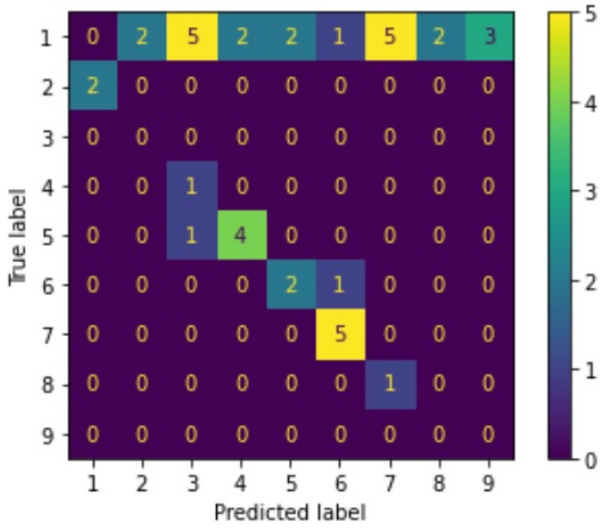


**Figure 17: Accuracy = 2.5%**